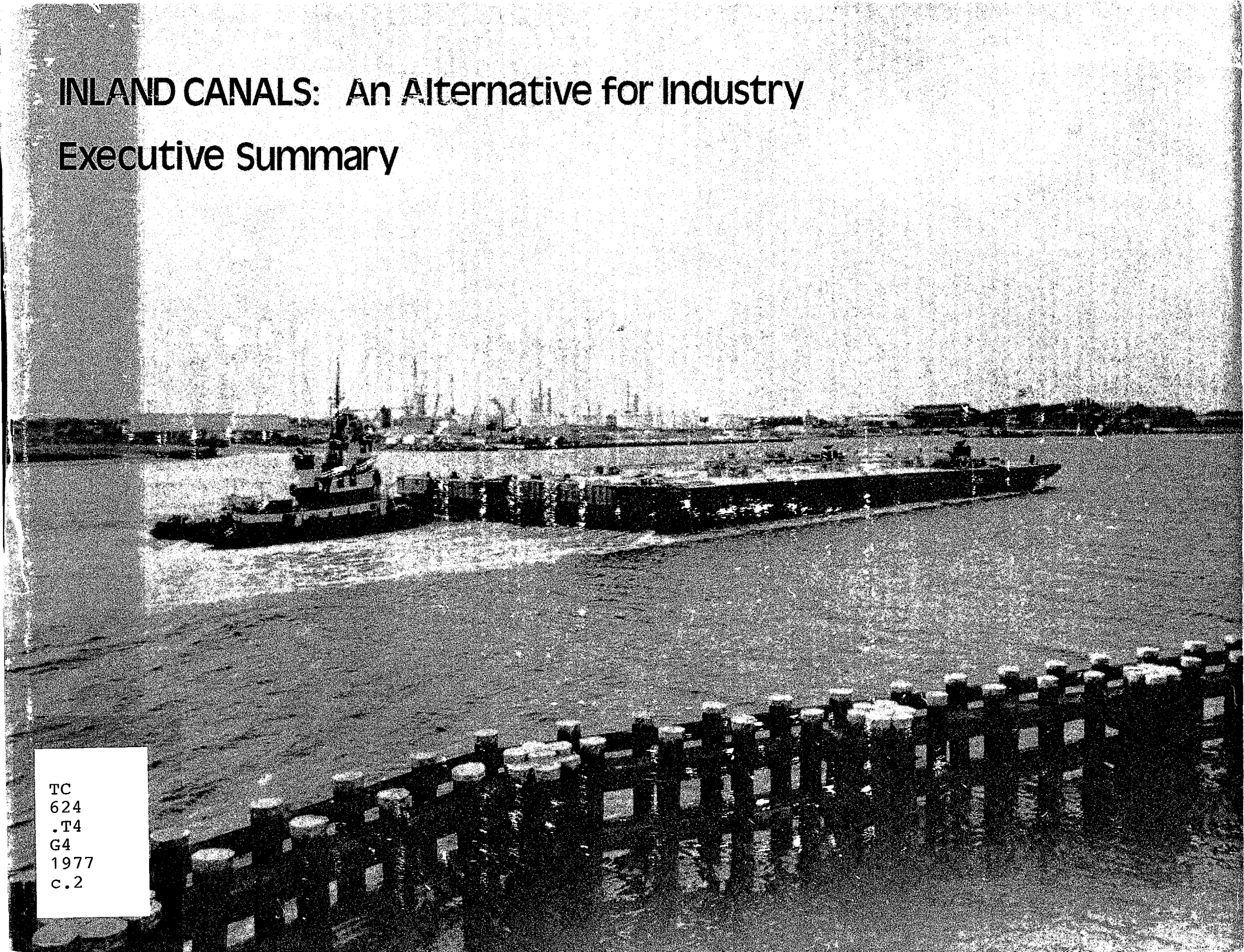
INLAND CANALS: An Alternative for Industry

Executive Summary



INLAND CANALS

An Alternative for Industry

Executive Summary

General Land Office of Texas

Bob Armstrong, Commissioner

December 1977

rpc RESEARCH & PLANNING CONSULTANTS

This report was funded through financial assistance provided by the Coastal Zone Management Act of 1972, administered by the Office of Coastal Zone Management, U.S. Department of Commerce.

FOREWORD

In February of 1977 the General Land Office contracted with RPC, Inc. to assess the feasibility of inland canals as a special study of the Texas Coastal Management Program.

RPC, Inc. has evaluated the concept through a hypothetical case study in Brazosport, Texas. The results of the case study indicate that inland canals are a feasible alternative to traditional navigation developments, both in terms of cost to industry and in minimizing adverse environmental, social, and economic impacts.

I believe that the study findings present important policy implications for accommodating industrial growth and economic viability while protecting our productive coastal resources. My staff will be using the study as we continue investigation of the state's policies regarding the siting of industrial facilities through formulation of the Texas Coastal Management Program.

Bob Armstrong

Bob Armstrong, Commissioner

GENERAL LAND OFFICE

PREFACE

Inland Canals — An Alternative for Industry is a highly technical report. This *Executive Summary* highlights that study, but in no way is it intended as a comprehensive summary of the entire report. The reader who desires more detail or documentation of the conclusions presented here is directed to the original study.

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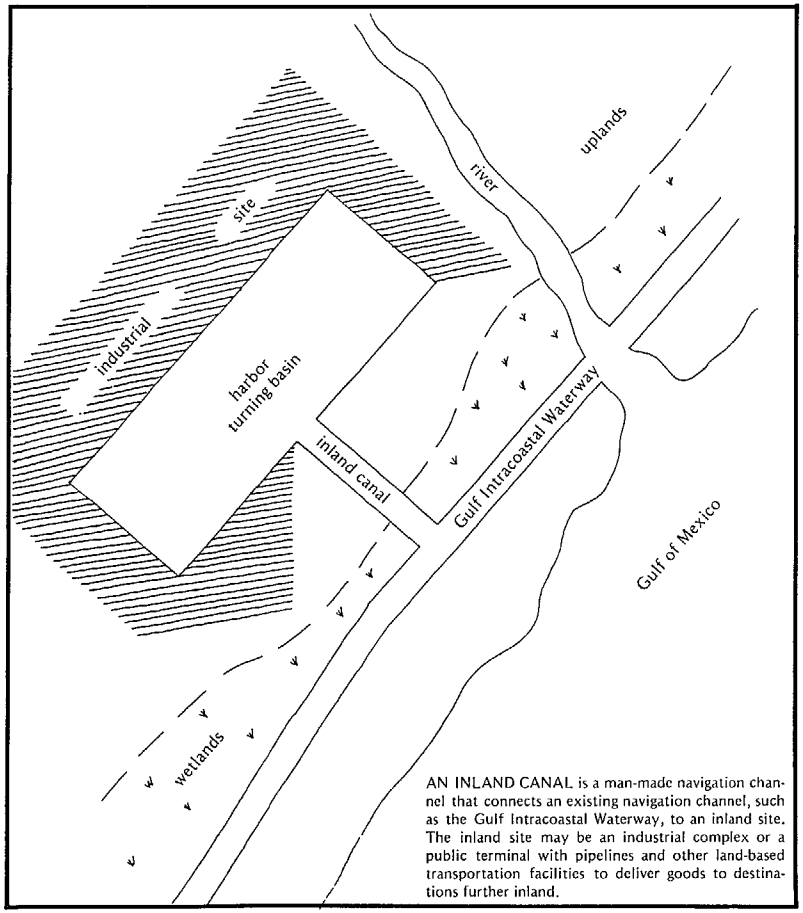

AN INLAND CANAL is a man-made navigation channel that connects an existing navigation channel, such as the Gulf Intracoastal Waterway, to an inland site. The inland site may be an industrial complex or a public terminal with pipelines and other land-based transportation facilities to deliver goods to destinations further inland.

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INTRODUCTION TO THE STUDY

The desirability of economical access to raw materials and to markets has historically encouraged industry to locate near the coast. Water transportation provides an efficient means of moving large quantities of materials, particularly in an international market. To supplement this attractive transportation interface, the Texas coastal region is also abundant in natural resources, resulting in an overall unprecedented demand for industrial location. At the same time, vocal interest groups and a multitude of governmental regulations reflect the importance of maintaining the renewability of these dynamic and productive coastal resources. Because an increasing amount of information is available concerning the vulnerability of the coastal ecology, there is every reason to believe that government will focus more attention on development in coastal areas in the future. Therefore, it is eminent that industry

and government alike begin serious investigation of alternatives that can meet the needs of industry while protecting our vital coastal resources. It was to this end that the study to assess the feasibility of inland canals as an alternative to industrial location on the coast was undertaken.

RESULTS OF THE STUDY

Inland Canals — An Alternative for Industry shows that industries do not have to locate at the edge of the Gulf or bays for access to a navigation route. It supports the possibility that industrial development on an inland canal is economically practical and ecologically desirable. The project design minimizes effects on upland ecosystems while protecting fragile marine ecosystems. Destruction or alteration of prime coastal resources is not always a necessary part of industrial access to navigation channels.

The results of the cost feasibility analysis indicate that with the purchase of 7000 to 10,000 acres of land, canal construction and site preparation would be a profitable venture for private investment. On the other hand, public ownership through a navigation district, for example, can confer unique financing advantages - particularly in the development of utilities.

The proper selection of the inland canal route can reduce wetland destruction and problems of disposing of dredged materials associated with traditional navigation projects. In fact, the project design uses excavated dredged materials for site fill and construction of levees. The levees provide additional protection against hurricane and river flood hazards.

STUDY DESIGN

The study models an industrial project using real data and criteria. From 18 potential sites, the Brazosport area of Brazoria County was selected as the location for the hypothetical inland canal.

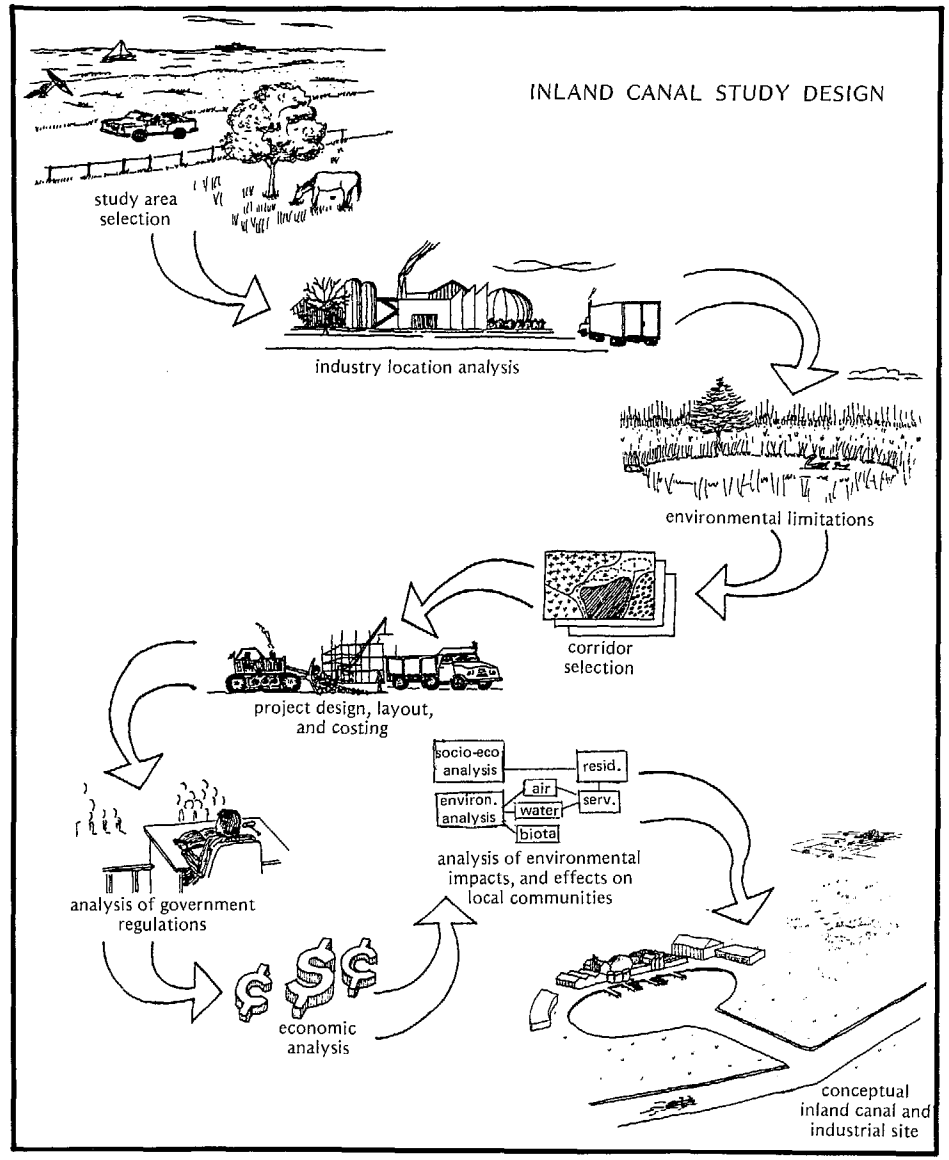
Based on environmental and socio-economic limitations of the area, an analysis of industrial requirements, and

the physical and industrial assets of Brazosport, the inland canal was planned for a chemical and refinery complex.

The study explores the feasibility of the project through a series of analyses involving (1) determination of industry requirements, (2) selection of a canal corridor and industrial site that would have the least impact on the environment, (3) site layout and design, and (4) economic feasibility. The environmental and socioeconomic effects of the proposed design are analyzed to ensure that the project design produces the least environmental change. The technique for assessing the impacts of the project is the Activity Assessment Routine of the Texas Coastal Management Program. This process makes use of a systematic approach to understanding and identifying potential alterations in ecological, social, and economic systems.

LESSENING THE IMPACTS OF THE PROJECT

The impacts on upland ecosystems that are anticipated as a result of canal



construction and industrial operation include habitat loss and disruption and alteration of waterflow patterns. However, these impacts can be lessened through proper design of the canal, industrial site, and levee systems.

Public participation and planning in the communities and rural areas affected by the canal can reduce possible deficits in county and municipal budgets. These deficits may come about as a result of new residents placing increased demands on existing public services, but they can be avoided, or at least minimized, through adequate planning.

LIMITATIONS OF THE STUDY

The scope of the study is limited to design and construction of the canal and preparation of the industrial site. Although significant operational issues are discussed, a detailed analysis of the construction and operation of specific industrial facilities has not been attempted because these phases are assumed to be similar for both inland canal and traditional industrial developments.

The many assumptions made in the study are believed to be reasonable, and the project design should lend itself to generalization. Even though the study is based on a hypothetical design, and the subsequent effects of the project are therefore probable in nature, inland canals are nevertheless found to be a feasible alternative for industrial location with access to navigable waters.

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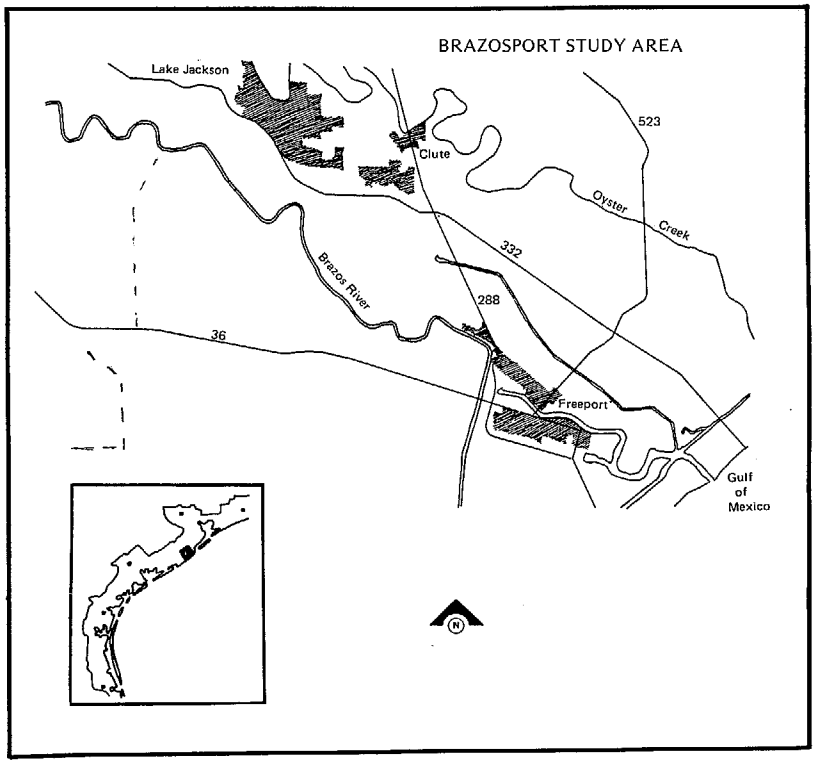
BRAZOSPORT, TEXAS

The Brazosport area of Brazoria County on the upper central Texas coast was chosen from 18 preliminary sites as the location for the hypothetical inland canal. Factors that were considered in selecting the study area include land use characteristics and transportation; social and community characteristics, including recreational opportunities and cultural and historical facilities; population and labor force; and environmental characteristics. Overall, these factors are favorable to the use of Brazosport as an inland canal and industrial site.

LAND USE AND TRANSPORTATION

Most of the land in the study area is open rangeland and woodland, providing the quantity of land needed for an industrial complex. There is good highway transportation, including three state highways and three farm-to-market

roads. In addition, the area is served by the Missouri-Pacific railroad, and there is a small public airport near the community of Lake Jackson. The city of Freeport has established waterfront facilities, including a barge canal operated by Dow Chemical Corporation.



SOCIAL AND COMMUNITY CHARACTERISTICS

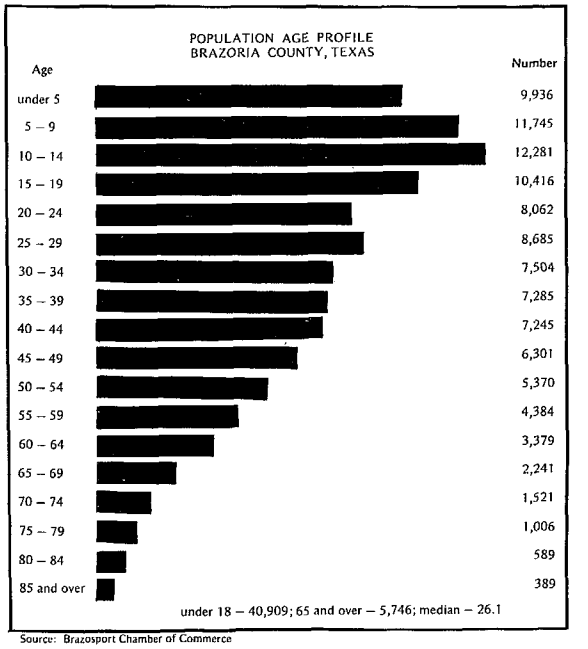
Brazosport is distinctive in its social and community characteristics. It consists of an industrial center in the city of Freeport, which is surrounded by the primarily residential communities of Surfside, Oyster Creek, Richwood, Clute, Lake Jackson, Brazoria, Jones Creek, and Quintana. Although the area is made up of these nine municipalities and several unincorporated neighborhoods, it tends to function as a single community. Not only do many residents work or shop in towns other than their own, but the area also shares a number of service systems, including schools (with the exception of Brazoria), the daily newspaper, and areawide governmental and cultural associations. Brazosport's recreational, cultural, and historical attractions will appeal to families moving into the area.

POPULATION AND LABOR FORCE

The population of Brazosport has been steadily increasing, making it one of the fastest growing areas in the state.

According to the 1970 census, the residents of Brazoria County tend to be well educated in comparison with state norms, and the median age for the county is 26.5 years. These characteristics indicate the existence of a sizeable qualified working-age population.

Most of the workers are employed by Dow Chemical and 86 other manufacturing plants in the area. The presence of these industries and the high construction and growth rate of the area result in an unemployment rate for the county that is below the state average.



Source: Brazosport Chamber of Commerce

ENVIRONMENT

Environmental characteristics, including climatic conditions, may significantly affect the suitability of an area for an inland canal project. The climate of the area determines the growing season for vegetation recovery, the number of days conducive to outdoor construction, and its residential desirability. The climate of the Brazosport area is characteristically subtropical, with short mild winters and long warm summers. High humidity and a uniform yearly rainfall distribution provide for a nearly year-round growing season and outdoor construction activities.

The entire Texas coast, including Brazoria County, is designated by the Environmental Protection Agency as a critical air quality zone. However, the impacts of industry on air quality in the

immediate Brazosport area are lessened by prevailing moderate winds, an absence of long-term or frequent surface air inversions, and unstable to neutral air layers. These factors combine to favor air mixing and dispersion.

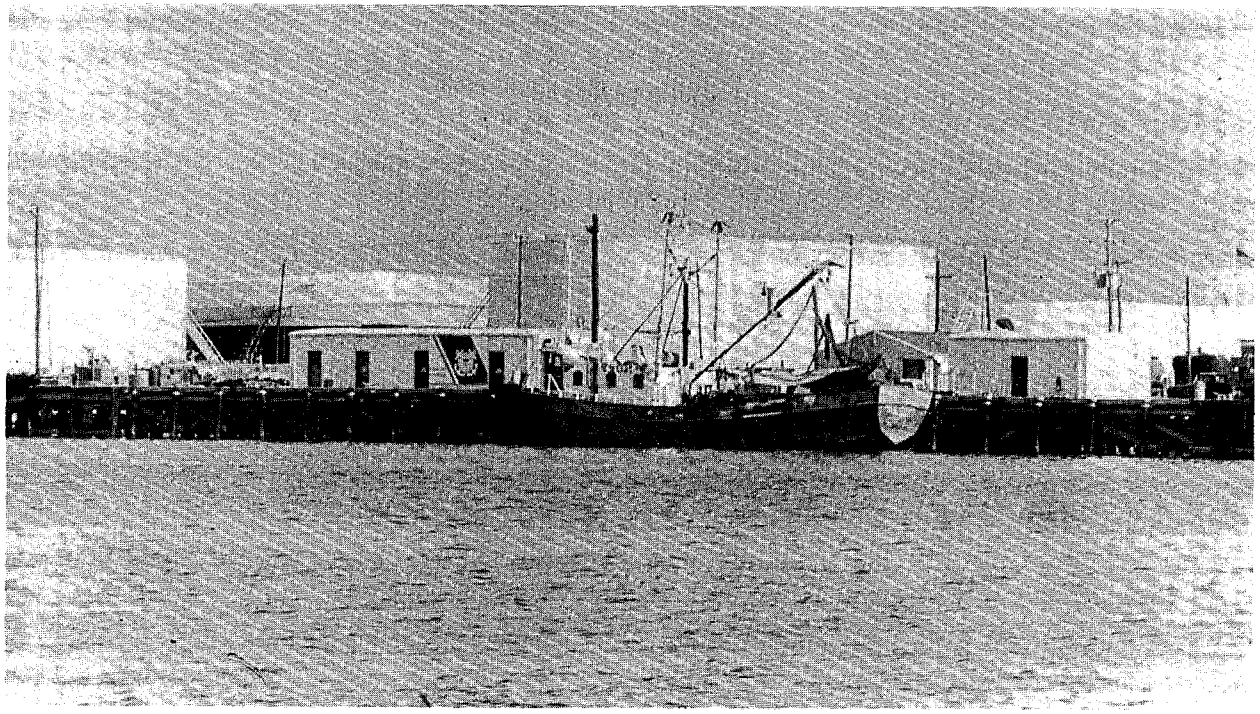
A possible shortage of groundwater; some evidence of faulting, or fractures in the earth; and the dominance of clayey soils may present some problems in canal construction and industrial site development. Surface drainage consists generally of a series of small isolated lakes, bayous, and marshes. To a great extent, soils determine drainage and runoff of rainwater: in general, the clayey soils have low seepage rates, and water tends to run off and collect in low-lying areas. Most of the area is less than five feet above sea level, so it is subject to occasional flooding.

The four major ecosystems in the area are brackish-water marshes; coastal prairie, which includes Gulf cordgrass prairie and the less frequently flooded shrub savannah; woodlands; and freshwater marshes and swamps.

The variety of ecosystems in the Brazosport area represent the environments of the Texas coast in general, and activities determined to affect these ecosystems can be generalized to other coastal areas.

CHARACTERISTICS OF BRAZOSPORT ECOSYSTEMS

Ecosystem	Terrain	Water characteristics	Dominant vegetation	Typical wildlife	Human uses
brackish-water marsh	very flat; numerous coastal lakes and interconnecting watercourses	salinity gradient across marsh from sea level (tidal influence) to upland prairie (freshwater runoff or rainfall influence)	saltgrass, olney bulrush, marshhay	blue crab, spot, anchovy, tidewater silverfish in tidal channels; nutria, muskrat, duck, goose, sandhill crane, and other migratory waterfowl; alligator; mosquito	hunting, trapping, fishing; grazing in upper marsh
coastal prairie (including Gulf cordgrass prairie and shrub savannah)	level; intermittent channels and poorly defined slough drainages	fresh water, sheet runoff and flow in several creeks and tributaries to major watercourses	Gulf cordgrass, Paspalum, coastal bluestem, Indiangrass, huisache, live oak, mesquite, retama	insects, hispid cotton rat, cottontail rabbit, raccoon, skunk, armadillo, coyote, seaside sparrow, marsh hawk, dove, quail, vulture, numerous songbirds; deer	grazing, residential development, sand quarries, industrial development
woodland	level, high bottomlands and levees; major watercourses	fresh water; source of water usually in river and major creek overbanking	pecan, live oak, hickory, sugarberry, elm, blackgum; varied brushes, shrubs	raccoon, fox and gray squirrel, opposum, white-footed mouse, cardinal, vireo, owl, vulture, many songbirds	residential subdivisions, clearing for development
fresh-water marsh and swamp	low shallow depressions and sloughs in uplands	fresh water supplied by small streams and river overbanking; soil surface saturated; usually standing water	sedges, spikerush, bulrush, cattail, sloughgrass, dwarf palmetto, bald cypress, water oak	nutria, muskrat, alligator, otter, raccoon, waterfowl, heron, egret, other shore and wading birds, turtles	hunting, trapping, fishing; physically unsuited to most human uses



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PROJECT FEASIBILITY

Different industries have unique land and waterfront requirements. Therefore, the types of industries expected to locate at the inland industrial site will influence the final size, design, and layout of the site.

INDUSTRY SELECTION

An analysis of industrial location factors indicates that a refinery and petrochemical plant complex can reasonably be expected to locate at the proposed site. This expectation is based on consideration of past waterway development patterns, the requirements of firms in these industrial sectors, and the capability of the Brazosport area to meet their needs. Brazoria County has the resources and characteristics to meet the general requirements of industries using water transportation, and of chemical and refinery plants in particular.

The chemical and refinery complex is the core of the site development, but other types of industry might locate along the canal. These industries include fabricated structural metal products and petrochemical and refinery service and supply firms.

DESIGN CONSIDERATIONS

The general approach to designing the inland canal and industrial site balances the interrelationships among industrial location factors, engineering alternatives, and environmental limitations. These interrelationships are diagrammed in the design criteria matrix on the right. However, at this stage of design it is impossible to predict with certainty the environmental impacts that will result. Because any project will obviously produce environmental change, most environmental constraints listed in the matrix are described as minimizing environmental change or maximizing existing conditions. Few environmental impacts can be absolutely avoided.

Industry Location Factors	land/site location
	access to navigable water
	sufficient development area
	building, process/storage, roads, parking/loading
	secondary industry and expansion area
	land transportation access
	highway
	rail
	product export pipelines
	industrial utilities, services, and facilities
	water for process, cooling, drinking
	solid waste treatment and disposal facilities
	liquid waste treatment and disposal facilities
	police and fire protection
	spill prevention and control facilities
	water transportation access
	suitable dimensions for navigation safety and efficiency
	suitable dimensions for projected barge/tow design
	access from GIWW
	suitable docking and cargo handling facilities
	access to raw materials (import)

DESIGN CRITERIA MATRIX

Three sets of criteria were used in selection and design of the inland canal and industrial site: industry location factors, engineering alternatives, and environmental constraints.

This matrix summarizes the three groups of criteria. The industry location factors and the environmental constraints are considered constant in the matrix. The engineering alternatives provide a checklist of variations in site characteristics or design that can be used.

Another way to use the matrix is as a tool for evaluating the tradeoffs between mutually exclusive objectives. In this context, the objective of achieving a location factor, such as access to navigable water, can be weighed against the opposing environmental constraints. For example, a site close to navigation may also be more prone to hurricane flooding and disturbance of wetland systems. Or the rapid growth associated with canal construction may also overburden existing social services.

The matrix, however, should be considered only as a design tool. Its use as an accurate predictor can be misleading, but it can be helpful as a reminder of available options.

Environmental Constraints / Engineering Alternatives	channel design and routing	channel route	(from GIWW to site)	(from GIWW via river to site)	channel and port geometry	(canal-river system)	channel dimensions	potential excavation materials	side slope stabilization	(vary route through stable materials)	(riprap)	(concrete lining)	(fabric)	minimum change in surface drainage	(siphon drainage crossings)	canal flushing	bulkhead and dock design	(concrete bulkhead)	type equipment	spoil disposal	(land)	(industrial site)	spoil disposal method	disposal control and dewatering	(at industrial site)	industrial site area	foundations	(naturally stable subsurface)	(excavate and backfill)	(piling)	(spread footings)	(slab)	water supply	(surface water)	(well field)	(desalt)	(salt water)	flood protection	(levees)	runoff control	waste disposal	(solid wastes)	relocations	pipelines	highways	(other than bridges and tunnels)	railroads	(highbridge)
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minimize disruption of wildlife habitat, migration routes, feeding zones		●			●		●							●					●	●				●																●	●		●					
avoid rare and endangered species habitat and rookeries		●												●					●	●				●																●	●		●					
minimize disruption of productive bay and estuarine areas		●												●		●			●	●			●	●										●		●	●			●	●				●		●	
minimize disruption of productive wetland areas		●			●									●						●				●														●		●	●		●					
minimize disruption to natural drainage, and maximize fresh-water inflow		●			●									●		●				●				●														●		●					●		●	
minimize erosion and sedimentation		●			●		●	●		●				●		●	●		●	●			●	●															●	●			●					
maximize air quality																		●							●																						
minimize disruption of aquifer recharge zones		●					●	●						●		●										●													●	●							
minimize disruption of riverine systems				●		●								●		●				●				●									●						●	●		●					
maximize biological productivity of inland canal		●			●				●									●																				●	●							
maximize water quality (canal, surface, subsurface)		●			●		●							●			●			●				●																●	●		●					
minimize flood potential					●									●																							●										
avoid areas of active subsidence		●			●																					●			●												●					
minimize accelerated subsidence														●																		●	●	●													
avoid areas of active surface faulting		●			●																					●			●												●					
avoid areas of active shoreline erosion																																															
preferentially develop on stable substrates		●						●																●			●															●					
minimize disruption of existing and potential human settlement		●			●															●					●																●					
minimize relocations of railroads and highways; maximum use of existing ROW					●																				●																		●			●
minimize congestion of existing land transportation		●																																							●		●			
minimize disruption of productive agricultural land		●			●																●				●																●					
minimize disruption of recreational resources		●			●														●						●								●									●					
minimize disruption of potential and existing extractive resources		●			●			●																	●																●					
minimize visual impact		●					●				●	●	●			●	●			●																		●			●				●		●	
minimize overburdening existing infrastructure					●																				●									●						●		●					
minimize loss to local tax base																									●																	●					

SELECTION OF THE CANAL CORRIDOR

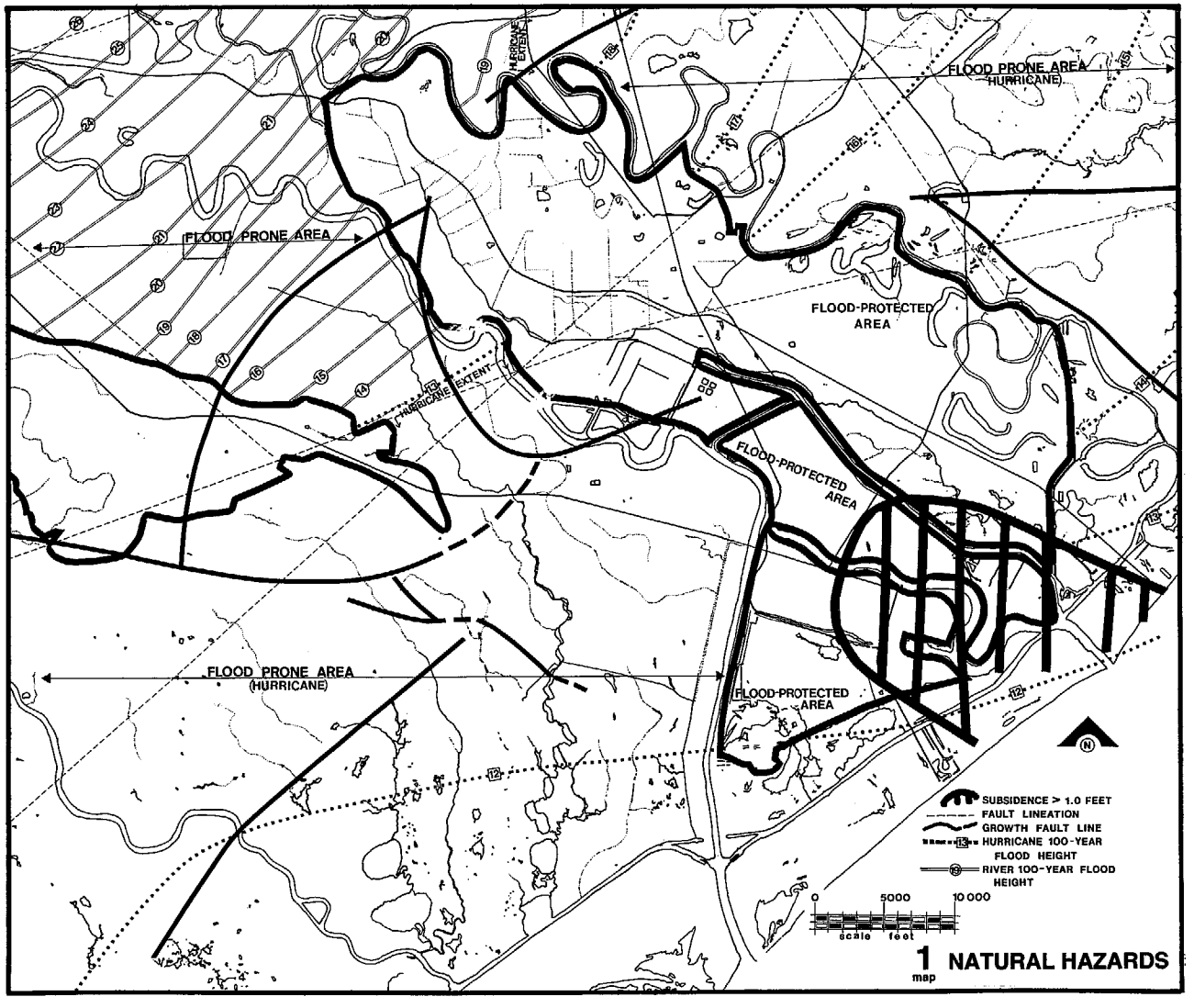
The canal corridor selected should have the least possible impact on the environment, and it should also have enough area for the industrial site layout. Six environmental data maps were prepared from the studies of Brazosport's ecological and physical characteristics. The elements of each map were evaluated by the study team and assigned a value. Higher values represent generally higher levels of constraint; lower values indicate areas of little conflict with development of the project. A composite constraint map, Map 7, was then prepared by superimposing each of the six evaluation maps. This composite constraint map shows the zones of highest and least constraint, and it was used to select the three alternative canal corridors and industrial sites.

These alternatives were selected by examining the composite map for appropriate distributions of low constraint areas to show the potential canal corridors and industrial development areas that would have the least effect on the environment.

The route selected is determined to have the least effect on the environment, and at the same time it meets the requirements of the project. This route, along Jones Creek ridge, is shown as Route I on Map 8. It has between 3000 and 8000 acres of developable land in a low-constraint area with enough additional available land to be used as buffer zones and flood protection areas. This route is wide enough for the canal, access roads, and drainage control levees. More than 50 percent of this corridor is owned by industrial firms open to land development, and most of the remaining land is available for purchase.

PROJECT DESIGN AND LAYOUT

The design and layout of the seven-mile canal and of the industrial site includes consideration of channel traffic demand, the required channel dimensions, methods of channel slope protection, and drainage control. A necessary diversion of Redfish Bayou entails special engineering considerations to avoid upsetting the ecological balance of the bayou.


FLOOD PRONE AREA (HURRICANE)
FLOOD PRONE AREA
FLOOD-PROTECTED AREA
HURRICANE EXTENT
FLOOD-PROTECTED AREA
FLOOD PRONE AREA (HURRICANE)
FLOOD-PROTECTED AREA
SUBSIDENCE > 1.0 FEET
FAULT LINEATION
GROWTH FAULT LINE
HURRICANE 100-YEAR FLOOD HEIGHT
RIVER 100-YEAR FLOOD HEIGHT
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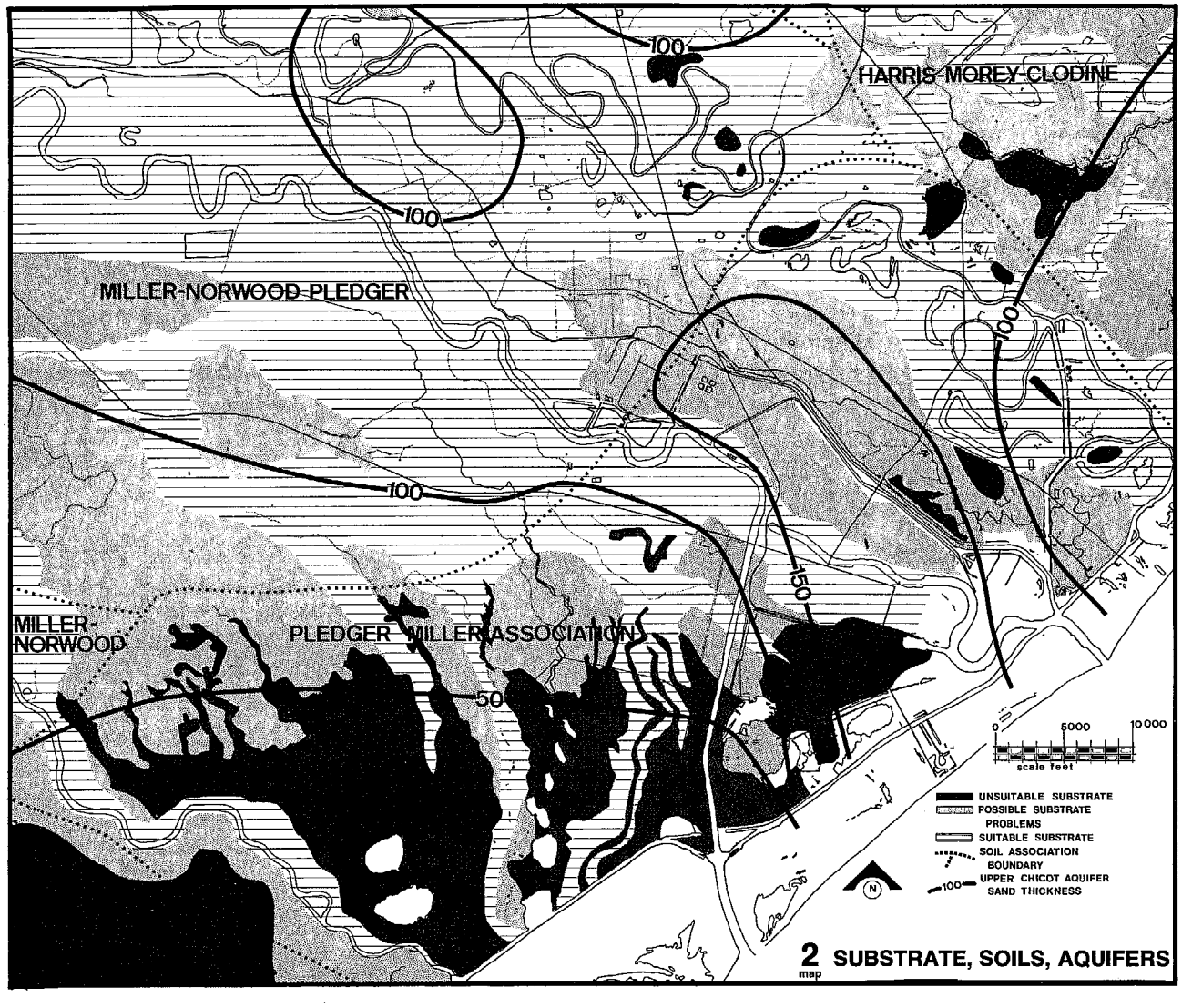
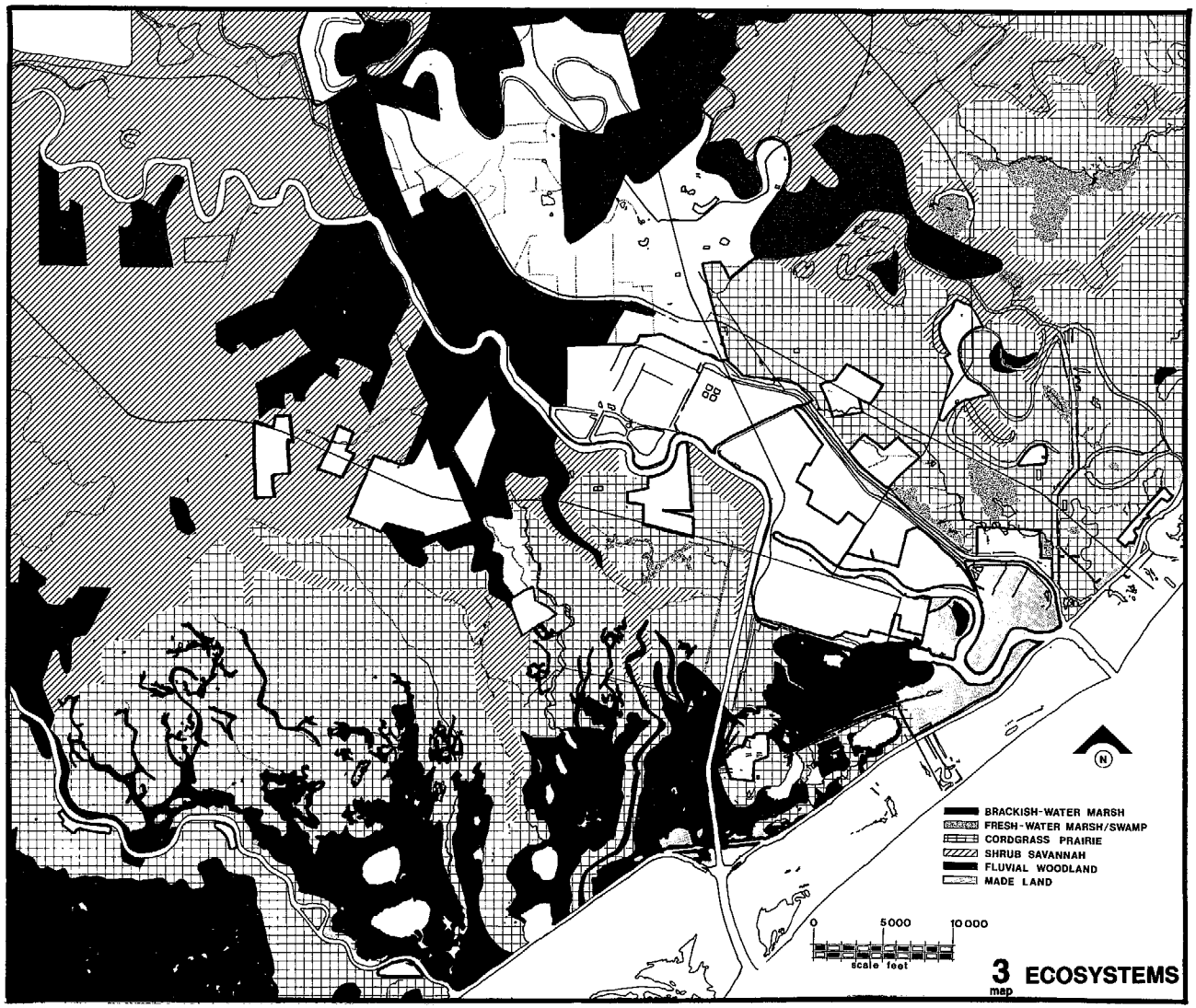
1 map
NATURAL HAZARDS



2 map **SUBSTRATE, SOILS, AQUIFERS**


BRACKISH-WATER MARSH
FRESH-WATER MARSH/SWAMP
CORDGRASS PRAIRIE
SHRUB SAVANNAH
FLUVIAL WOODLAND
MADE LAND
N
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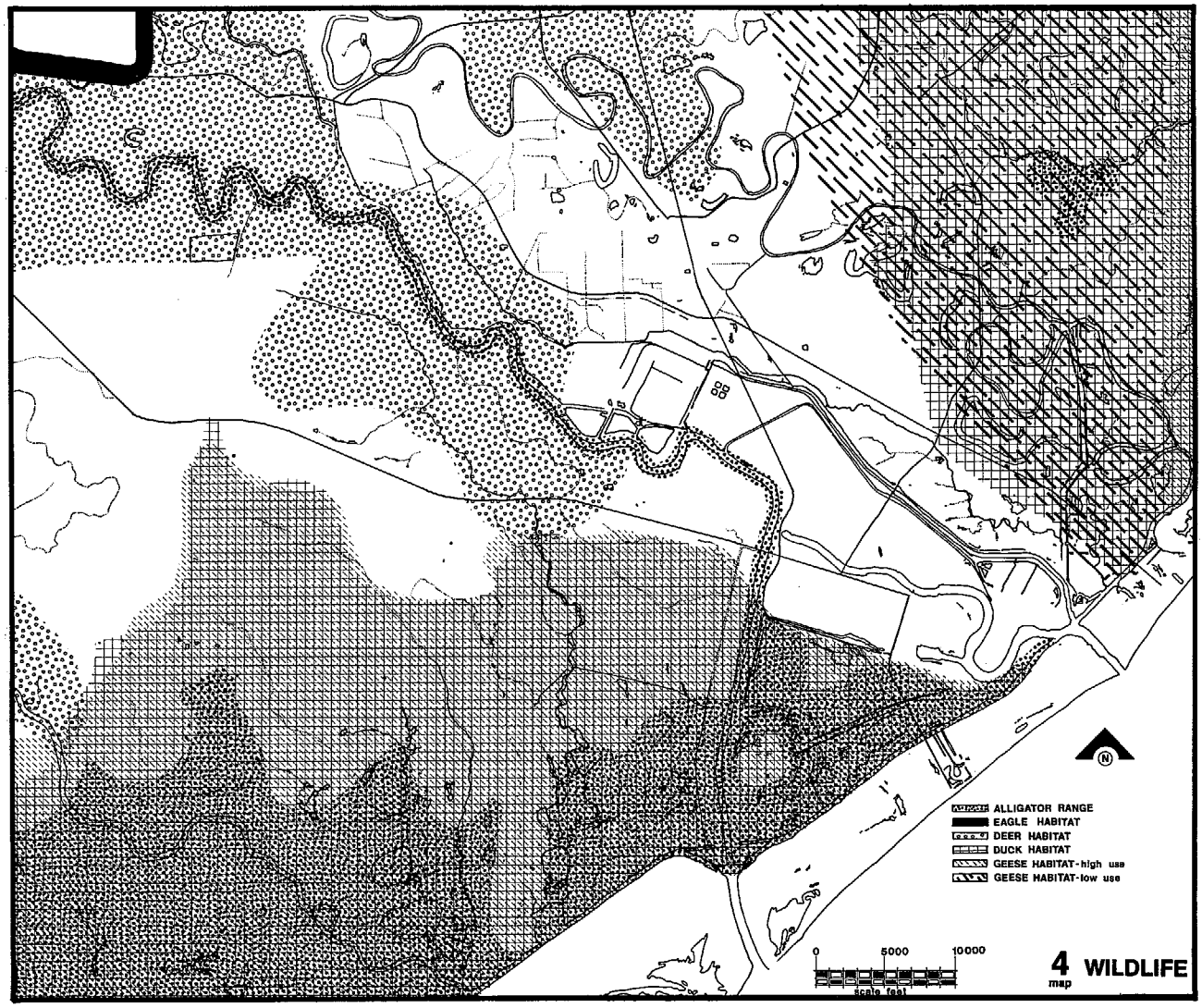
scale feet
3 ECOSYSTEMS
map


ALLIGATOR RANGE
EAGLE HABITAT
DEER HABITAT
DUCK HABITAT
GEESE HABITAT-high use
GEESE HABITAT-low use
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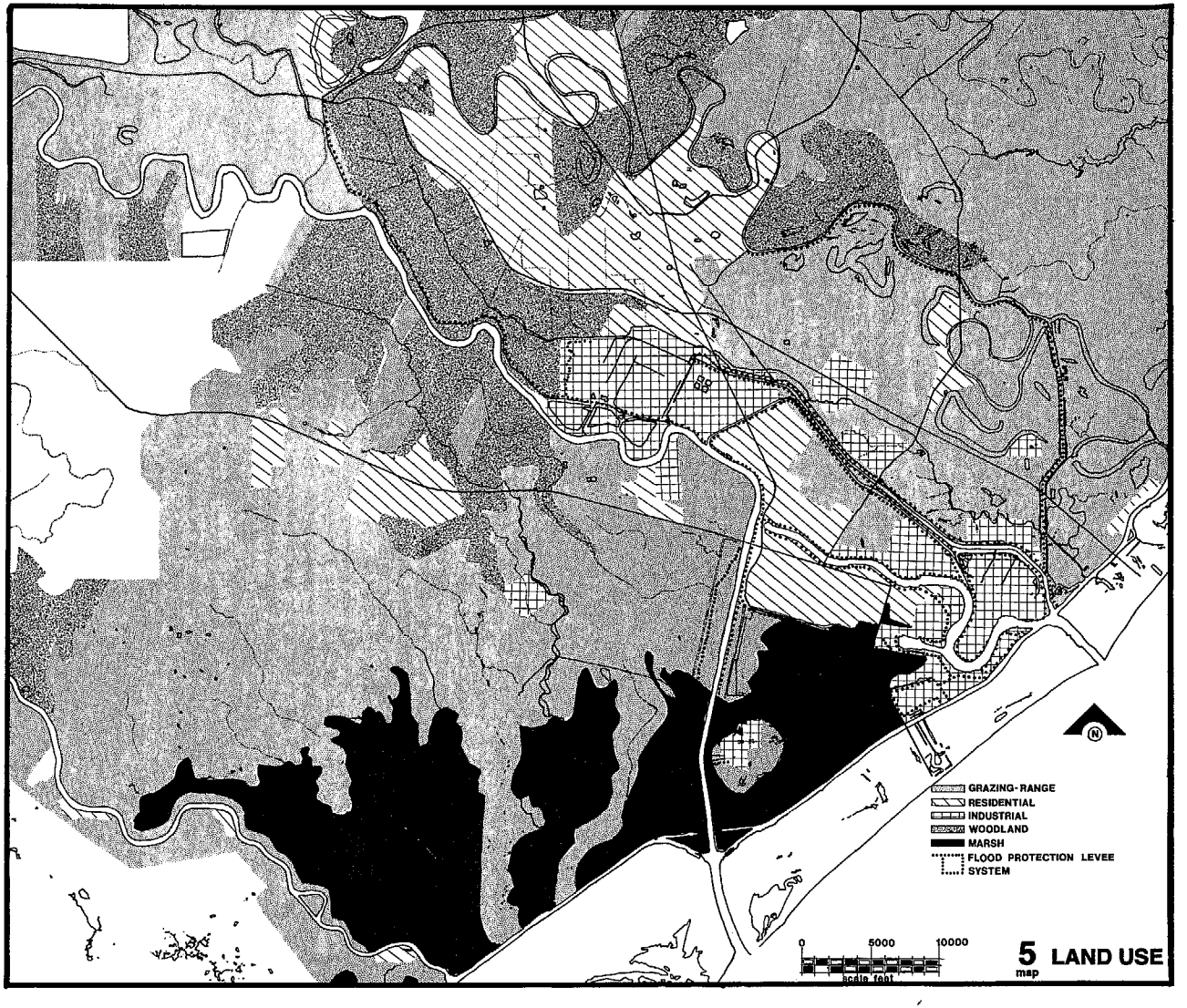
4 WILDLIFE
map


GRAZING-RANGE
RESIDENTIAL
INDUSTRIAL
WOODLAND
MARSH
FLOOD PROTECTION LEVEE SYSTEM
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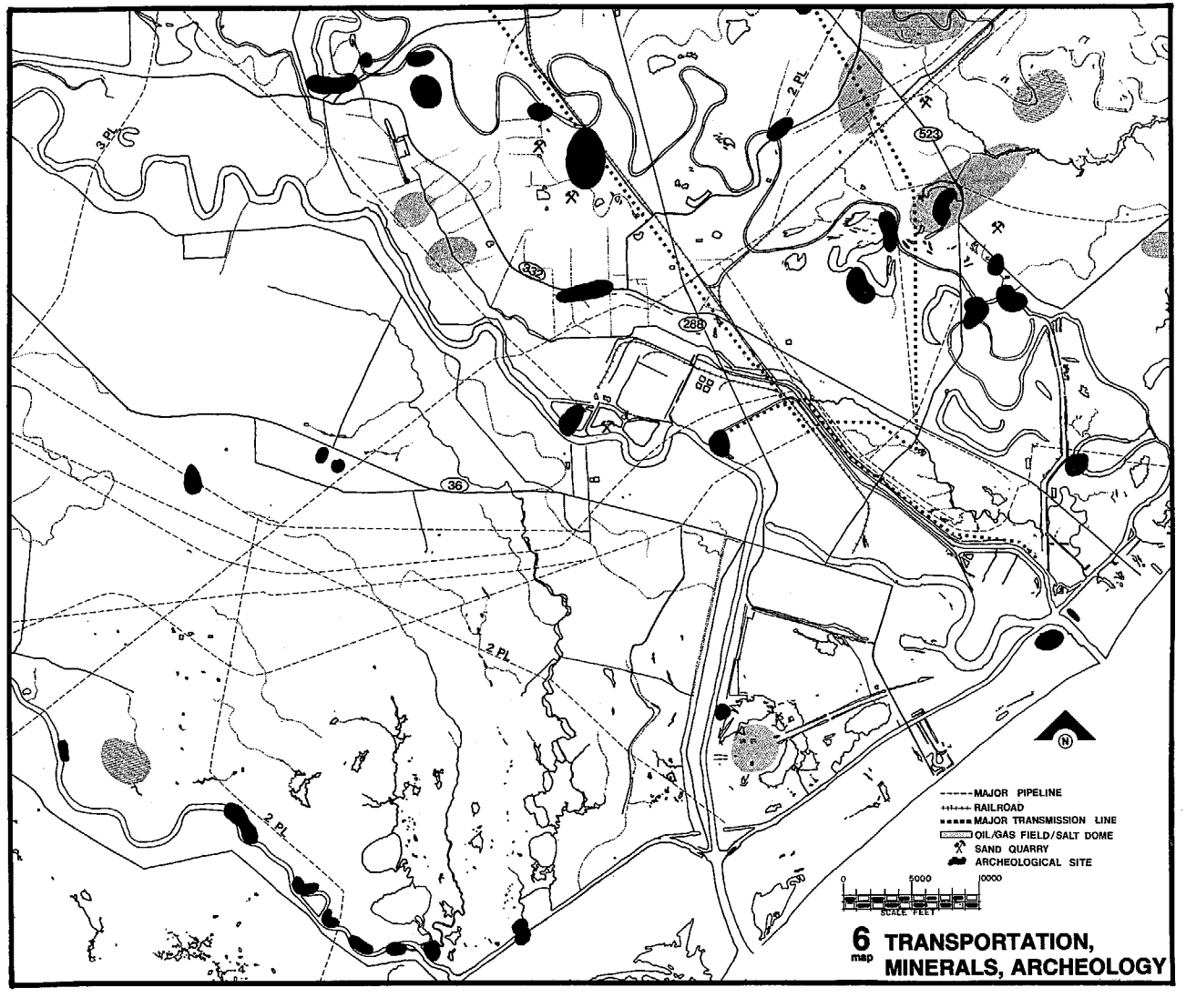
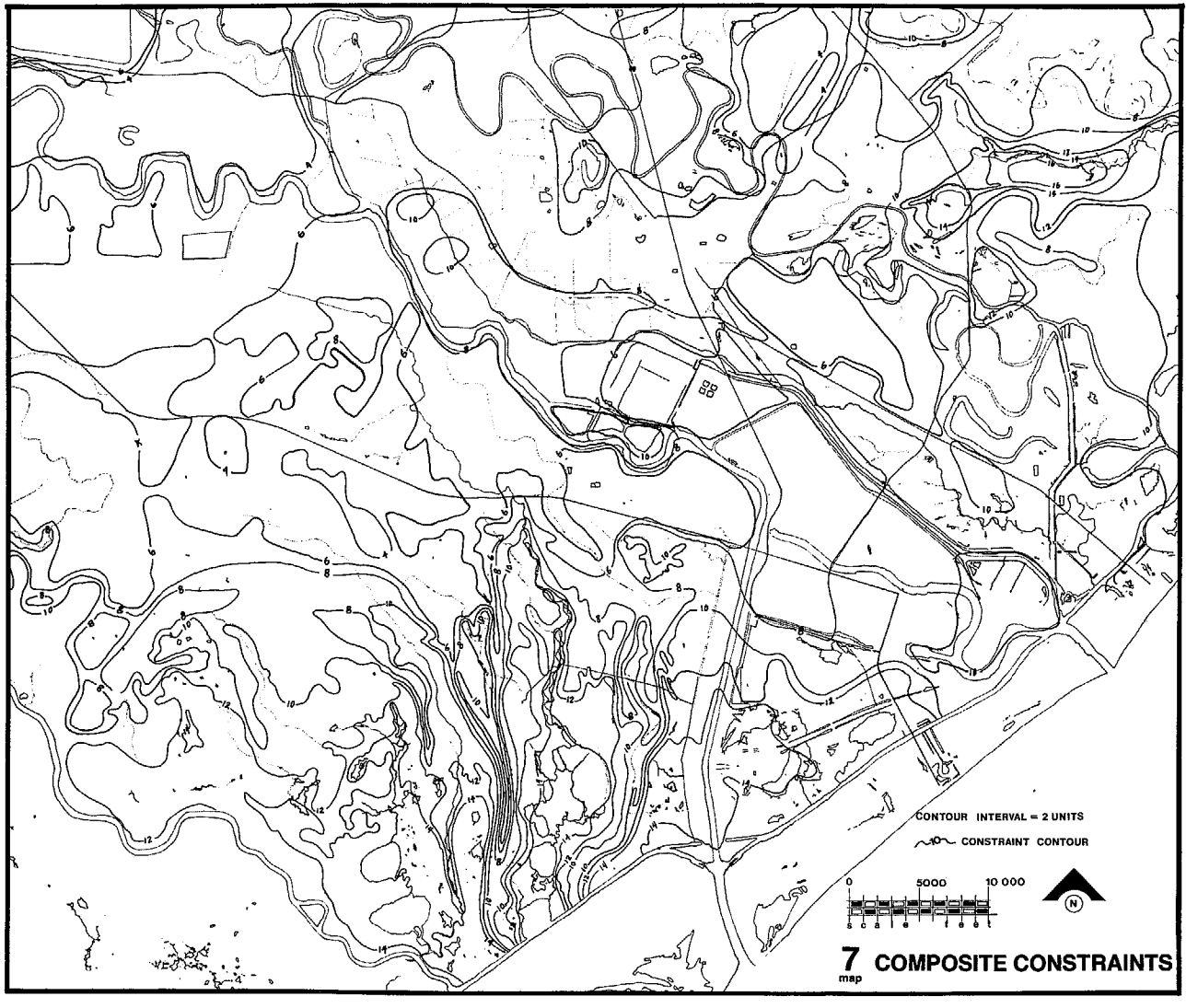
scale feet
5 LAND USE
map


3 PL
2 PL
2 PL
2 PL
523
332
288
36
MAJOR PIPELINE
RAILROAD
MAJOR TRANSMISSION LINE
OIL/GAS FIELD/SALT DOME
SAND QUARRY
ARCHEOLOGICAL SITE
5000
10000
SCALE FEET
6 map
TRANSPORTATION, MINERALS, ARCHEOLOGY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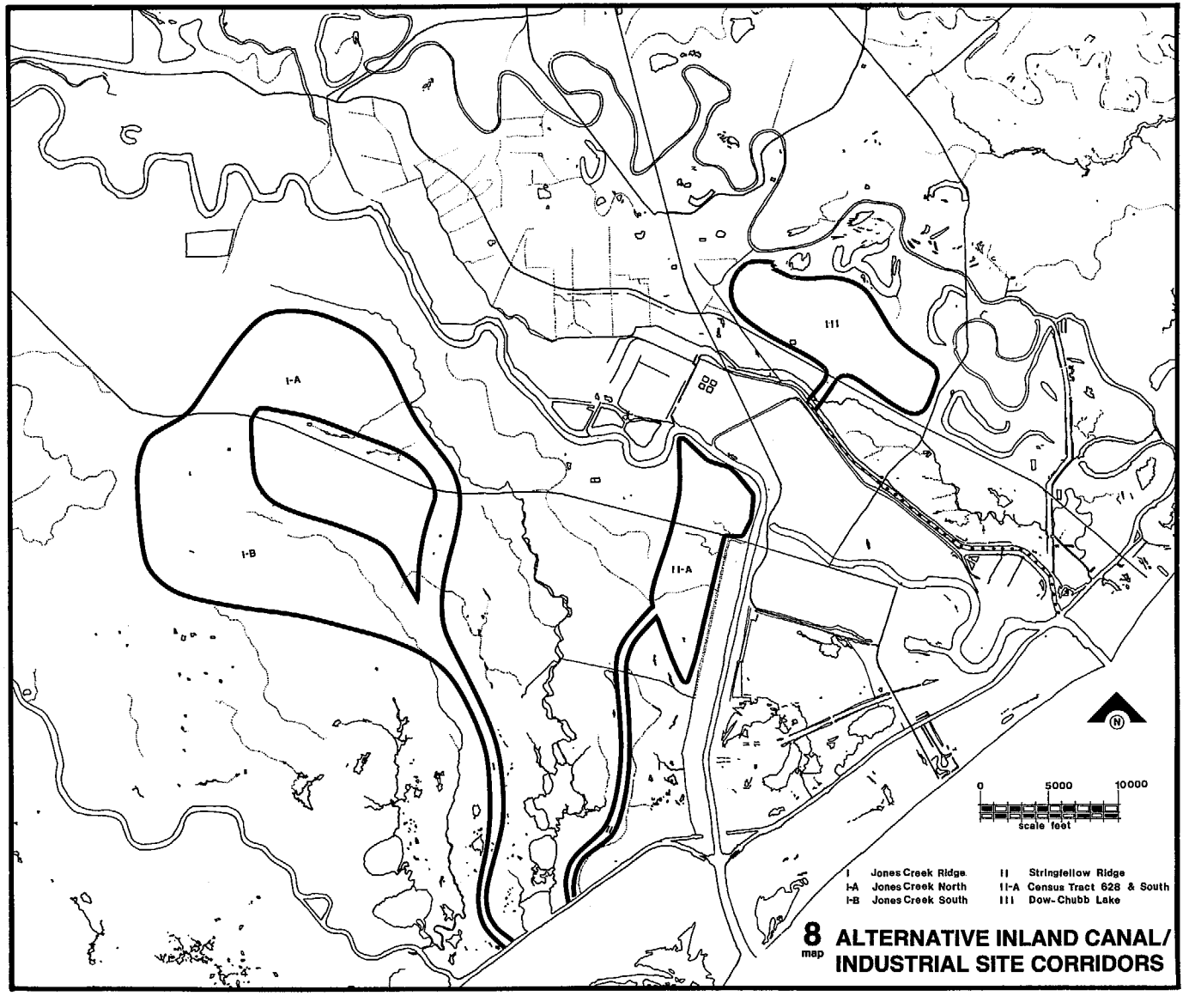
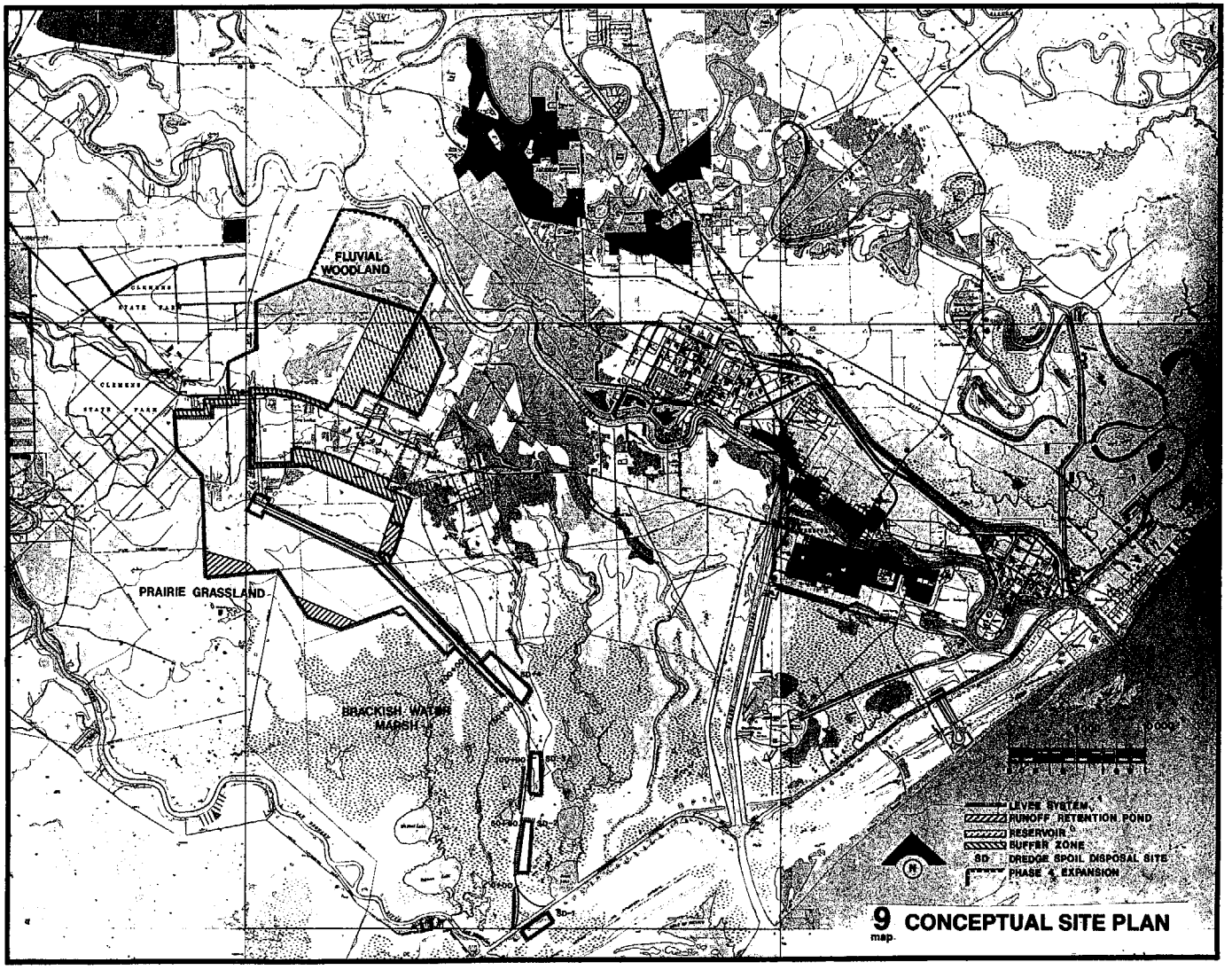
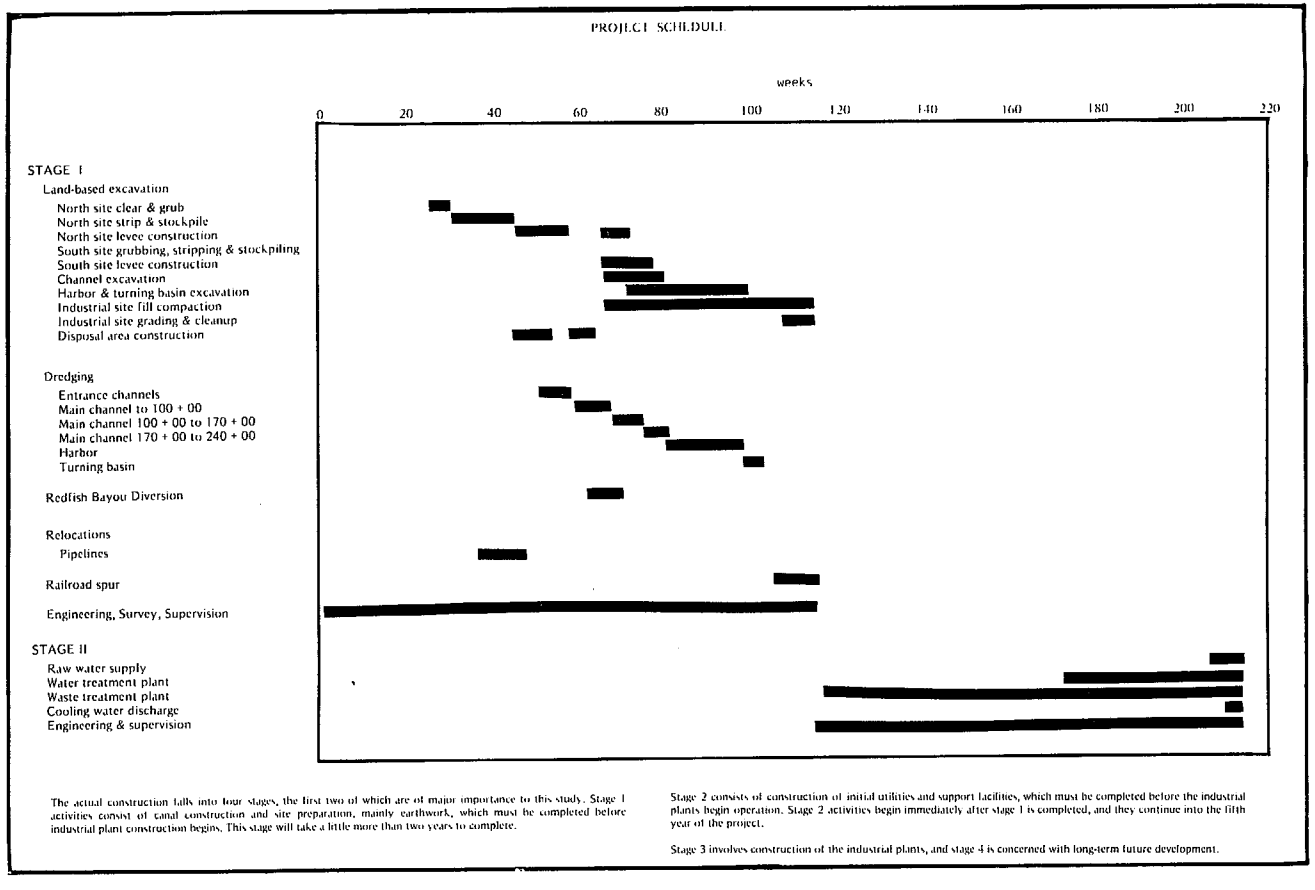
7 map
COMPOSITE CONSTRAINTS



8 map **ALTERNATIVE INLAND CANAL/ INDUSTRIAL SITE CORRIDORS**



9 map. **CONCEPTUAL SITE PLAN**



In addition, the project design includes dredged material disposal sites, the harbor layout, and layout for the industrial site and administrative facilities. Dredged material from the upland reaches of the canal is used to construct flood control levees and raise the elevation of the industrial site.

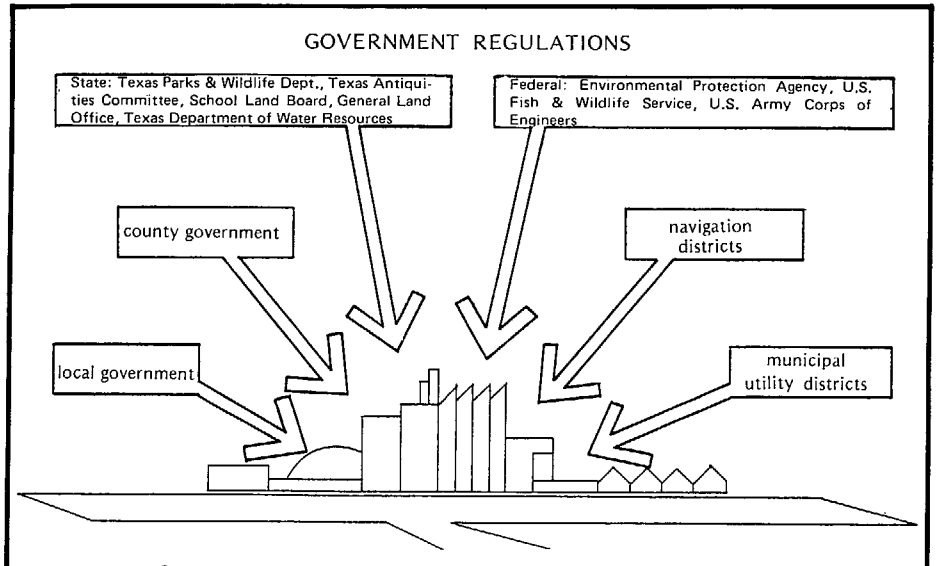
Special provisions were made for site drainage, runoff retention ponds, flood protection, reservoir design, and buffer zones to separate the industries from nearby land uses. The initial utilities are also provided for in the project design, as are rail and highway access to the site and possible relocations of pipelines, homes, or historical or archaeological artifacts.

COMPLIANCE WITH GOVERNMENT REGULATIONS

The design of the inland canal incorporates provisions to minimize environmental changes that often result from traditional development. Because of its environmental considerations, the inland canal designed in this study is expected to comply more easily with government regulations than would a traditional industrial navigation project.

ADVANTAGES TO INDUSTRY

The inland canal also appears to offer advantages to industries locating at the site. The development of the project as a single planned unit relieves individual tenants of the responsibility for securing permits for construction and maintenance of the access channel, berths, and major utilities. Individual industrial operating permits will be required, but the project developer could



Project development will be affected by various federal, state, and local government regulations and taxing entities. Government agencies at all levels will require permits for construction of the canal, preparation of the industrial site, and construction and operation of the industries that locate at the site.

carry out a preliminary investigation of the features necessary for compliance.

Operating restrictions are generally not expected to differ significantly between an inland canal development and other industrial sites. One possible exception is in meeting air quality maintenance restrictions. Less concentrated industrial developments with dispersed emission sources may more easily meet air quality requirements. However, this issue may be resolved in part through public financing of pollution control facilities.

FINANCING THE PROJECT

It is feasible for the canal project to be either publicly or privately financed. Public entities that might finance the project include the U.S. Army Corps of Engineers, navigation districts, county governments, or municipal corporations. A potential disadvantage of public financing is that tax revenues generated by the development would be reduced until tracts are purchased by industry. Private ownership could consist of individual industries, a real estate development corporation, or an industrial partnership.

There are several governmental assistance programs that may be used to lessen potential unfavorable environmental, social, or economic impacts of the project. In Texas, most of these federal programs are administered by the Texas Department of Community Affairs.

Services such as security, fire protection, maintenance of common areas, spill prevention and cleanup, and maintenance of roads could be provided by the developer, or they could be provided separately by each tenant. Some or all of these services provided by a single source for all project industries would be the more economical approach. The developer could provide the services and charge the industries accordingly, or the tenants could form an association to finance and manage the services.

ECONOMIC FEASIBILITY ANALYSIS

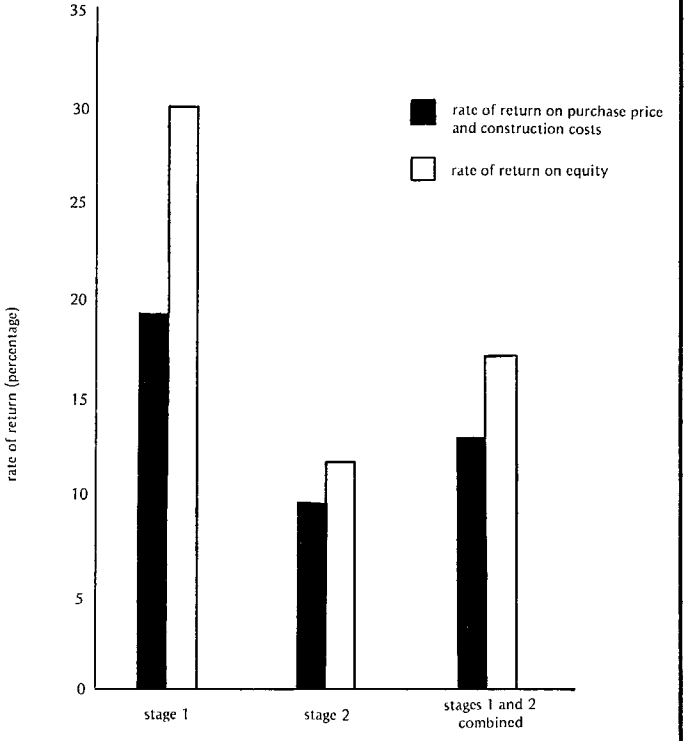
The economic feasibility analysis consists of two parts. First, the project costs are compared to the present market for industrial land with similar features. In the second part, the project cost feasibility is tested in an analysis of cash flow over the life of the project and

COMPARISON OF RATES OF RETURN FOR PRIVATE FINANCING

Assumptions for Stage 1 Economic Analysis

The cash flow and rate of return for stage 1 of the project are calculated on the basis of the following assumptions:

1. Of the 9777 acres to be purchased for the project, 7109 acres are available for sale. It is assumed that all will be sold.
2. The total land cost is $20 million. The acreage prices range from $500 to $3000 per acre; average price is $2045 per acre.
3. Financing will be a $13.5 million loan with an interest rate of 10 percent. The principal will be repaid through payments of $2800 per acre. An acceleration factor in the release payments of approximately 16 percent is applied.
4. Development of the project is predicated upon a purchase commitment by the refinery and petrochemical industries. The lower price per acre for their waterfront sites reflects their early commitment and purchase of larger tracts.
5. Acreage prices are intended to compare with other full-service industrial parks. Waterfront acreage is approximately 50 percent more costly than nonwaterfront; prices escalate over time.
6. Rate of land sales (as a percentage of total) is based on historical patterns, although the total number of years to full occupancy could vary.
7. Real estate taxes are based on an average assessment of $1000 per acre. The accumulated tax of $18 per acre is based on the rates of the various taxing authorities in Brazoria County as listed by Seadock, Inc. in 1974. Taxes on undeveloped land, such as the buffer zone, will continue beyond the absorption period.
8. Expenses calculated for the cash flow analysis include the following:
   a. Seven percent sales expense as commission to external sales efforts
   b. Engineering and contingency expenses, which are expected through the life of the project
   c. Direct overhead, which includes the project owner's development and management staff
   d. Promotion, signs, and internal sales efforts in advertising and seeking tenants
   e. Legal fees, auditing, etc.
   f. Management fees, which account for head-office expenses in the parent corporation(s)
9. Annual interest payments are based on one year's interest on the remaining balance after the release payment is made and one-half year's interest on the release payment.
10. A short-term loan at 12 percent interest would be used to meet a deficit shown in the second year and would be repaid in the third year.



a rate of return on investment. Net gains or deficits determined in the economic feasibility analysis are calculated before taxes. Consideration of taxes may have an advantageous effect on the totals.

In general, an investment with a 20 percent rate of return, or rate of recovery of the initial investment, is considered to be a sound venture. The best financing arrangement for an inland canal project would be private financing of stage 1, which has a rate of return of 19 to 30 percent. Stage 2 is only a marginal venture for the private investor, having a rate of return of only about 10 percent. Because stage 1 is not feasible without utilities, public financing is seen as the best alternative for stage 2 development. A public entity can better withstand the slow recovery rate of utility construction costs.

Public financing of stage 2 can result in a gain of more than eight million dollars over a 10-year period, but actual surplus over expenses for this stage will depend on the rates charged for utility services. With public financing, the surplus revenues over expenses could be applied to navigation improvements, they could be fed back into local communities to ease the impacts of the project, or they could be reflected in lower utility rates.

4

IMPACTS OF THE PROJECT

The ecological impacts of the inland canal and industrial development will be far less than those engendered by traditional industrial siting. However, because of its scope, the inland canal project, like all major developments, will affect the economic, ecological, and social systems of Brazoria County to some extent. This chapter describes the anticipated impacts of the canal project and suggests planning considerations to offset them.

ECONOMIC IMPACTS

Through the use of an input/output model of Brazoria County, it is projected that $6.6 million, or about 12 percent of all construction expenditures, will be made in Brazoria County. It is also projected that $2.2 million in primary income will accrue to resident or new resident employees, and the county will benefit from over $280,000 indirect income resulting from the project.

The actual fiscal impact on any unit of government will vary depending on the level of construction-related expenditures, which would generate tax revenues, and the number of new residents, which would increase demands for public services. Perhaps the most significant impact of construction of the canal and preparation of the industrial site is the possibility that local governments in the county will experience a financial deficit.

EFFECTS OF THE PROJECT'S EMPLOYMENT REQUIREMENTS

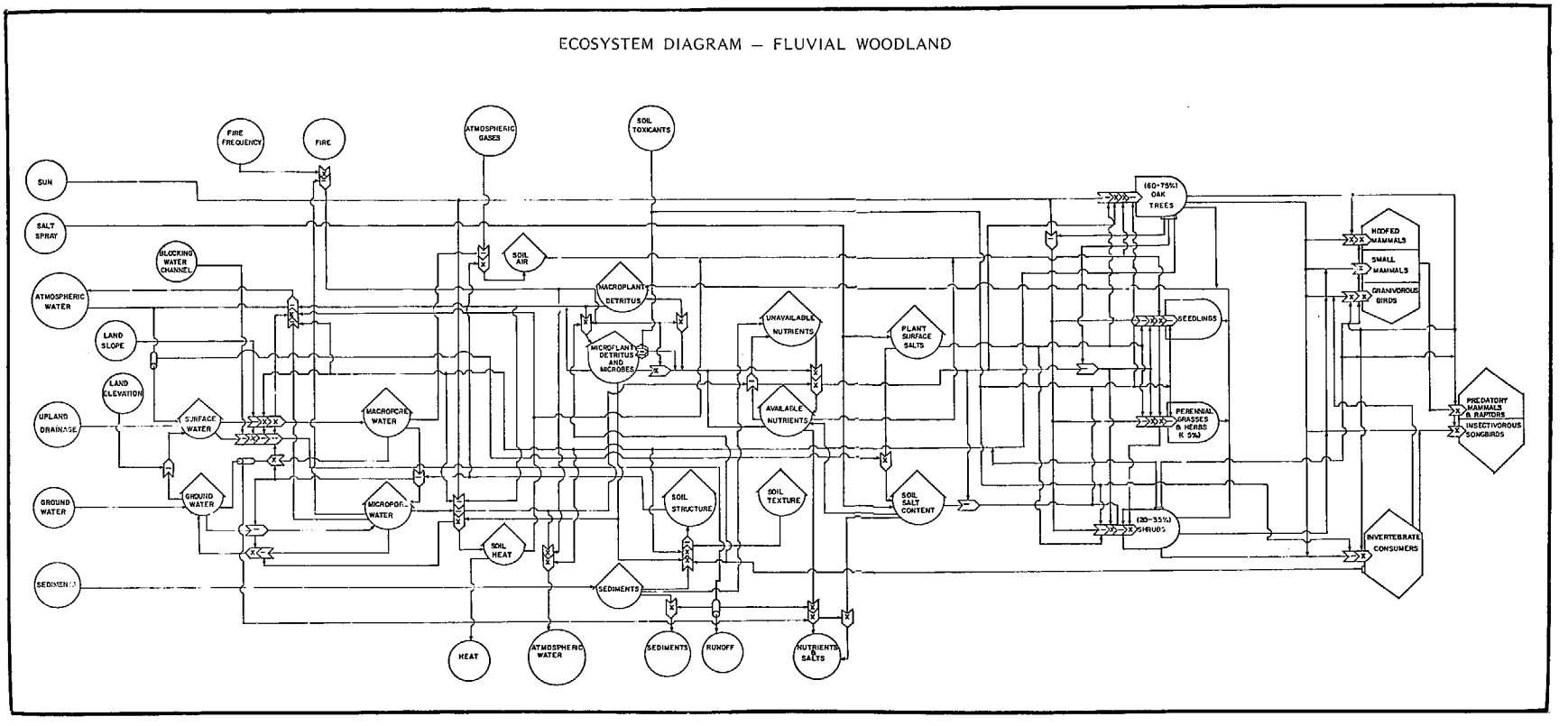
The new population associated with the construction project is primarily a function of the new employment; the same can be said of the number of new housing units and the number of new students. Thus, the first step in calculating new population, housing units, and students is to calculate new employment; the first step in that process is the determination of manpower requirements for the various project activities.

Each of the construction activities has its own employment requirements. Because the activities occur at different times, the total employment varies between time periods, as the employment associated with one activity ends and another begins. The figures given here are the maximum expected increases for the project's activities in stages 1 and 2. These maximums occur toward the end of stage 2; preceding activities will require fewer employees.

However, it cannot be assumed that all economic activity associated with the canal construction will occur in Brazosport nor that all tax revenue will fall to local governments in Brazosport. First, the county government will collect some of the taxes. Second, not all of the purchases in the county by the construction firms and workers will be made in Brazosport. Brazosport will benefit, however, to the extent to which money is spent in the area and to which new employees and their families locate there.

ECOLOGICAL IMPACTS

The ecological effects of constructing an inland canal and industrial site are determined through use of a specialized procedure called the Activity Assessment Routine. This procedure is



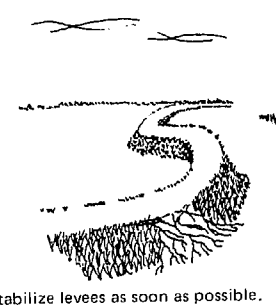
based primarily on the use of ecological systems diagrams to depict the functions and interrelationships between the abiotic and biotic constituents of an ecosystem. This "map" of a system's dynamic properties helps visualize the chains of impact that may occur through alteration of the system.

Thus, the ecological effects of canal construction are predicated on the basis of a thorough analysis of the components, flows, and regulating factors in each ecosystem affected by the canal and industrial site. The major ecological impacts identified are:

1. Habitat loss and disruption
2. Decreased surface-water runoff and erosion resulting from exposed soils
3. Possible changes in downstream flow conditions due to diversion of Redfish Bayou under the canal
4. Alteration of the existing sheetflow runoff to more directionalized flow, resulting in possible changes in the distribution of marsh wildlife and vegetation

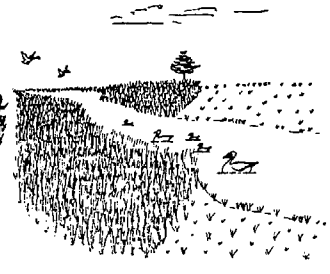
There would generally be little additional ecological impact caused by refinery and chemical plant construction. The construction activities would occur on an already modified industrial site, which by design includes various safeguards for water runoff and protection of local waterways against pollution.

ADJUSTMENTS TO DECREASE ECOLOGICAL CHANGES

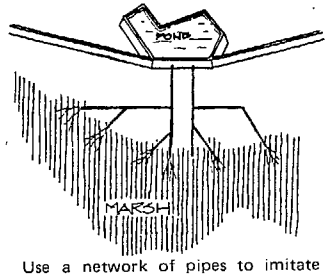


Stabilize levees as soon as possible.

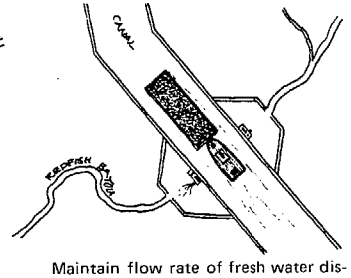
Schedule excavation and dredging to occur after migratory birds leave for the winter . . .



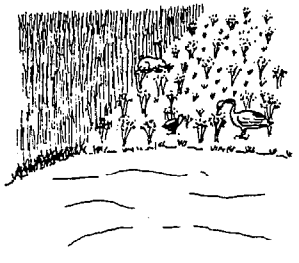
. . . so new vegetation can be established when they return in the spring.



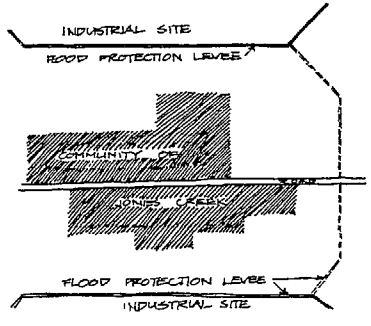
Use a network of pipes to imitate sheetflow run-off from retention ponds.



Maintain flow rate of fresh water discharged into Redfish Bayou.



Encourage the abundance of more desirable varieties of marsh grasses. This could enhance food resources of the marsh.



Extend flood protection levees around the eastern side of the community of Jones Creek.

There are alternatives that can be used to decrease unwanted impacts on the environment. It should not be assumed that these adjustments can completely avoid impacts of construction and development, but they will decrease them. However, the best possible adjustment is likely to be very costly. Consideration of the cost of a particular adjustment must be balanced against the importance of the impact it would modify.

SOCIAL AND COMMUNITY IMPACTS

Because social impacts are difficult to assess, it is important that project developers work closely with local residents from the planning stages of the inland canal. Developers should advise the citizens of potential impacts and determine their attitudes toward existing or future industrial development in their area.

The assessment of social impacts associated with a construction project differs in a number of ways from economic, environmental, and governmental considerations. People living in different areas may have dramatically different ideas of what constitutes a pleasing social environment. In addition, groups of people living in the same area may have distinct ideas of the kinds of changes that would have negative or positive effects on their lives. For example, new residents may see increased development as positive, while long-time residents may see it as a threat to their established way of life.

The officials and residents of Brazosport seem to be aware of the need for careful, long-range planning. In addition, the nine local governments coordinate their planning efforts and services, which increases their ability to deal with the problems of growth. However, certain issues and services may require particular attention in local planning efforts. These include housing, educational facilities, medical facilities, transportation, and flood protection.

Because of its nearness to the proposed industrial site, the town of Jones Creek may be negatively affected in a number of ways. Jones Creek is a small town and quieter in nature than the more populous areas of Brazosport. Most of the few commercial enterprises are located along highway 36. The canal would certainly disrupt the relative isolation and quiet of the town. The construction might also require relocation of a small number of families.

5

A COMPARISON OF INLAND CANALS WITH TRADITIONAL DEVELOPMENTS

A comparison of inland canals with traditional industrial location assumes that the differences, rather than the similarities, between the two approaches are important. The major difference is that an inland canal approach will result in changes to upland habitats, whereas traditional navigation developments generally result in wetland habitat loss and disruption.

UPLAND vs. WETLAND ECOSYSTEMS

Many attempts have been made to measure the absolute values of various types of wetland and upland ecosystems, but as yet a direct comparison in terms of human values cannot be made. However, an important conclusion of this past research is that coastal wetlands

have a high ecological value. Recognition of this value has resulted in the development of state and federal policies to protect and maintain coastal resource areas.

The inland canal project proposed in this study succeeds in minimizing the environmental impacts that are typical of traditional projects. In addition, the project design is based on economic, environmental, and engineering considerations. These considerations in the project design reduce many of the undesirable impacts that are foreseen from development of the inland canal and industrial site.

The comparison of inland canal and traditional shoreland industrial development shown in the following table emphasizes the major ecological advantages of the inland canal alternative. The greatest advantage is in its location in an upland area that is carefully selected to ensure that ecological systems are least affected by construction and operation of the canal and industrial site. Habitat losses that do occur are in upland resource areas, protecting the flora and fauna of tidal bayous, rivers, and coastal wetlands and lakes.

Interference with water systems and patterns of water flow is minimal, as the canal is designed to avoid natural drainage courses. The inland canal alternative also eliminates the disposal of dredged material into the endangered wetlands. Much of the dredged material is used for construction of levees and for elevation of the industrial site. In addition, location of the canal along an upland drainage divide minimizes the required maintenance dredging associated with shoreland developments.

RURAL vs. URBAN INDUSTRIAL LOCATION

Social and local governmental impacts depend on where the industrial site is located in terms of city and county jurisdictions. Generally, industrial navigation developments are located along coastal waterways in or near urban areas. With an inland canal, industrial development would likely be in a more rural setting.

Because of its rural location, the inland industrial complex is likely to be outside the taxing jurisdiction of cities in which the construction and operation

COMPARISON OF SHORELAND INDUSTRIAL DEVELOPMENT WITH INLAND CANALS

Impact	Traditional shoreland *industrial development*	Inland canal *industrial development*
location	reclaimed marshland, bay margin, or upland environment	suitable upland area with least effect on the environment
habitat loss	tidal bayous, rivers, and coastal wetlands and lakes	upland resource areas, such as prairie grassland
effect on water systems	disrupts bottomland or tidal stream drainage channels and associated water-flow characteristics in nearby low-lying areas	cuts new navigation route across upland areas, intentionally avoiding natural drainage courses.
natural hazards	vulnerable to hurricane surge flooding	upland location provides protection from hurricane surge flooding
levee systems	extensive levee system required for flood protection	fewer levees required, especially as industrial site is elevated
disposal of dredged material	wetlands	next to channel in upland ecosystem; industrial site fill and levee construction
maintenance dredging	location within watershed requires frequent maintenance dredging	location along upland drainage divide minimizes required maintenance dredging

workers reside. The workers demand public services of these cities, but the cities do not receive tax dollars from the industrial site. Short-term fiscal deficits and decreases in the quality of available public services would be more likely to occur with an inland canal development.

The inland canal industrial complex may also have a greater effect on land prices and land use patterns than would urban industrial developments. The escalation of adjoining rural land values may be more abrupt than if the area were already influenced by industry. The relative value of this impact would depend on whether one is buying or selling the land.

Although construction and operation of an inland canal present some economic and social disadvantages, many of these impacts can be lessened through adequate planning and project design. Others will be offset by the positive aspects of growth, such as increased sales by local businesses and increased tax revenues. Careful coordination of the project with local residents and officials will go a long way toward keeping undesired impacts of rapid growth at a minimum.

CONCLUSION

This study shows that the inland canal concept can be a feasible alternative to traditional shoreline industrial developments. The proposed canal design minimizes the alteration of valuable coastal wetland systems while providing a suitable industrial site with barge access to the Gulf Intracoastal Waterway. A logical extension of this concept would be to provide deepwater access to an inland industrial site or common terminal.